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ABSTRACT

Writers who compose on computers have often complained of the difficulty they have in evaluating and correcting their work on the screen, particularly if the changes necessary are large, structural ones. A study of six freshman composition students and five writers experienced with computer writing examined how each used hard copy printouts of their compositions to supplement their evaluation of their work. Over a four-month period, the writers kept logs of their writing, noting when they made hard copy printouts, why, and what troubles they experienced with evaluating their compositions. Results initially suggested that the subjects used printouts (1) to check formatting (2) to proofread (3) to read the text to reorganize it, and (4) to read the text critically. Further study suggested that paper copy printouts were used differently when the tasks were either familiar or "knowledge forming," or long or short. Final results suggested that short, familiar tasks were easier to evaluate on the screen than long, knowledge forming ones. The findings of the study suggest that computer researchers may wish to work with software developers to alleviate difficulties with reading on computer screens, and that composition teachers working with students may wish to point out the dangers of relying completely on evaluating on-line and the benefits of hard copy evaluation. (JC)

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What Research with Computers Can Tell Us about the Uses of Reading in Writing

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The general area we call "computers and writing" is an active one currently, and many people within this area have become interested in the effects of computers on writing. However, "the effects of computers on writing" is a complex and sometimes confusing issue. In the literature, we see a lot of contradictory claims about the effects of computers on writing, but little conclusive research. Teachers and educators disagree--sometimes fervently--about the place of computers in the writing classroom. While all this ferment may not be surprising--it can at least partly be explained by the fact that when we talk about "computers and writing" we are often talking about very different things.

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[Insert Figure 1 here]

Some of us are interested in social effects--how computers effect the kind and number of interchanges between student and teacher, for example, or how computers in the writing classroom change the structure of those classrooms (Arms, 1987; Bernhardt and Appleby, 1985). Some people are interested in attitudinal effects--how computers change people's attitudes about writing (Daiute and Taylor, 1981). Others of us are interested in how computers effect the written product--its length, quality, structure (Gould, 1981; Haas and Hayes, 1986; Hawisher, 1986).

Some of us have a cognitive focus, and are interested in how computers effect the processes by which writing is produced (Bridwell, Sirc, & Brooke, 1985; Daiute, 1984; Haas, 1987; Woodruff, Lindsay, Bryson, & Joram, 1986). Still others of us are interested in the changes in writing curriculum that computers might facilitate (Kaufer, Geisler, & Neuwirth, in press), or drawing on historical parallels, how computers as a technology may help redefine writing itself (Ong, 1982; Perkins, 1985; Provenzo, 1986).

To complicate matters further--running through this diverse set of interests is another distinction we often fail to make: some of us focus our attention on computers as tools for **teaching** writing--computer-aided and computer-based instruction--while others of us are interested

in computers as tools for **writing** per se--word processors and text editors.

This paper describes preliminary results of work recently begun under a 3-year grant from FIPSE exploring the effects of word processing on writing. While our primary focus in this project has been on the **cognitive** effects of using word processing--how writers who use word processing adapt or modify the process by which text is produced--I see our work as having implications in each of these areas, and we hope the connections between our approach and the approaches of others can be made even stronger.

The focus of the current study is on the effect of word processing on **evaluation.** Drawing on a cognitive process model of composing (Flower & Hayes, 1981; Hayes & Flower, 1980), we have defined evaluation as the reviewing of one's own text that may occur throughout the composing process. We predict that word processing may have an impact on evaluation for several reasons.

First, evaluation or reviewing of one's own text is primarily a reading activity. Writers read their own texts to detect errors, to judge coherence and organization, and to determine if the text meets their intentions (Hayes, Flower, Shriver, Stratman, & Carey, 1986). However, research has consistently suggested that reading on a computer screen is problematic.

Reading speed is slower when test-taking (Hansen, Doring, & Whitlock, 1978), and comprehension test scores (Nelson-Denny) are poorer (Heppner, Anderson, Farstup, & Weiderman, 1985). In addition, many writing-related reading skills seem to be poorer and/or slower on-line. Proofreading speed and accuracy are eroded (Gould & Grischowsky, 1984; Wright & Lickorish, 1983). Retrieving information and reading a disorganized text in order to reorder it are both slower on a computer screen than they are on paper, although the size of screen that people are reading from is a significant variable. In addition, spatial recall (or remembering where in a document a specific piece of information occurred) is poorer on a standard terminal (Haas & Hayes, 1986).

Second, data we have collected in interviews with people who write using word processors has suggested the people have trouble reading when writing with a computer or word processor. Although in general I have found writers to be enthusiastic about using a word processor to write, one of computer-writers most recurrent complaints is that **reading** their texts on-line is difficult--not surprising given the results of computer-reading studies. The writers' complaints ranged from "it's hard to proofread on-line" to "I really have no sense of the whole text when I see it on the screen." In order to overcome these reading difficulties, we found that writers report making **extensive use of hard copy printouts** to read their own texts (Haas and Hayes, 1986).

An Observational Study of Writers' Reading Problems

In order to find out more about reading difficulties that writers who use word processors encounter and the way the employ hard copy to solve these problems, we designed a study, driven by this research question: Can we find consistent patterns in writers use of hard copy printouts for evaluating their own texts?

The study employed naturalistic methods and a case study approach. For the course of 4 months we tracked 11 case studies: 6 freshmen enrolled in writing with computers classes and 5 more-experienced writers--people who had had several years computer experience and for whom writing constituted a major part of their work activities. All writers used the same computer for writing--the Andrew system currently under development at Carnegie Mellon University (Morris, Saytanarayanan, Conner, Howard, Rosenthal, & Smith, 1986).

During the semester, the subjects were interviewed periodically about their writing with word processors; they were observed while writing in their natural environments--offices, classrooms, or terminal rooms; and they kept process logs of the writing they were doing on-line. In the logs they were asked to note particularly when they used hard copy and what they used it for. The students kept logs of all their writing; the more experienced writers--since many of them spent most of every day writing--contracted to keep logs for some part of their writing.

The data collected (over 600 pages, about 50 pages per subject) were very rich, and included transcribed interviews; writing process logs; copies of all texts, notes and drafts produced; and field notes collected by the experimenter during observation sessions. The excerpts below from writing logs and from transcribed interviews give a feel for the data; the two subjects featured in the excerpts provide contrasting examples.

[Insert Figures 2a and 2b here]

While Writer One, Diane, noted several reasons for using hard copy in her log--among them checking order, marking the text, and critical reading--the comments in the log of Writer Two, Matt, indicate that he was using hard copy for fewer reasons--to check the length of the text and to turn in to his instructor. In the interviews, Matt was pressed to mention any other reasons for using hard copy, but he mentioned no other reasons. In fact, in a part of the interview which unfortunately was not able to be transcribed, Matt said he thought it was "neat" that he could write, as he said, a "quote--paper" without "ever putting it on paper."

Diane, on the other hand, seems to like using paper when she writes on-line. The hard copy seems to give her some distance from her text, and allows her to read it critically. While Matt likes to write a "paper" without ever seeing it on paper, Diane doesn't seem to think her text is

a "paper" until she sees it on paper. While this study was not designed to explore factors which might contribute to Matt and Diane's contrasting behaviors, it does tell us more about how these eleven writers used hard copy while they were writing. This observational study was designed to tell us more about how these eleven writers used hard copy while they were writing; it cannot, however, tell us much about the factors which might contribute to Matt and Diane's contrasting behaviors. It can as well suggest possible contributing factors which might contribute to Matt and Diane's contrasting behaviors, although as a observational study it is better able to postulate hypotheses than test them.

We found that these computer-writers used hard copy for reading, and they used the hard copy for reading for four distinct purposes:

> **Checking formatting:** Writers often generate a print out of their texts to check margins, page breaks, or the placement of illustrations. For students particularly, this concern often seemed to take the form of checking to see if they had reached the minimum (or maximum) length specified by the teacher for the assignment.
>
> **Proofreading:** Many writers indicated that they do not "trust" their ability to proofread on-line and they generate hard copy in order to check for proofreading errors. This

behavior makes sense, given the results of on-line proofreading studies (Gould & Grischowsky, 1984, and Wright & Lickorish, 1983; for a discussion of display factors contributing to poorer on-line proofreading, see Gould, 1987.)

Reading to reorganize: Writer also used hard copy for planning and testing large text reorganization moves. While word- and sentence-level revisions and reorganizations are easy on a computer, writers reported that computers constrain large text reorganizations--involving a move of several paragraphs of text, or a move over a large amount of text space. As one writer put it, "That's when you just have to get your pen and spread the thing [the text] out all over the floor." In a previous experimental study, we found that students reading to detect needed reorganizations worked more slowly on a PC screen than they did on a larger screen or on paper (Haas & Hayes, 1986).

Critical reading, or "getting a sense of the text:" Writer also used hard copy to read their texts critically and to assess how well the text met their own intentions, what Witte (1985) calls matching of the projected text, or "pre-text," to the written text. Writers often used the words

"sense of the text" when describing this problem--"With the computer I have no sense of the whole text." Some writers used metaphors to describe the problem: "My text is hard to pin down on-line;" "There is a problem getting a feel for the piece;" "It's hard to get your center of gravity in the writing." The problem commonly seemed to occur in this way: the writer produced some amount of text, stopped to check progress, assess results, or match text to goals, and discovered that he/she could not adequately assess the text when it is on-line. So the writer generated hard copy, read the printout, then either made changes (on-line or on paper) or--satisfied that the text was all right--resumed computer writing.

Figure 3 shows examples of each kind of hard copy use. (These reading problems are described more fully in Haas, in press.)

[Insert Figure 3 here]

It may be important to recall that these writers were using the "Andrew" system--Andrew has a large screen, bit-mapped, black-on-white display. We might expect that reading problems of writers using more conventional systems would have even greater reading and evaluation problems.

The instances of hard copy reading were coded according to how the

hard copy was being used. Preliminary reliability check revealed close to 90% agreement with a trained rater. Although the number of instances of hard copy use for the two groups were similar (T = 75 for the students; T = 80 for the more experienced writers) there were some interesting contrasts between the two groups in how hard copy was used. Of a total of 75 instances of hard copy use for reading, 75% of the students' use was for checking formatting time, 13% was for proofreading, 8% was for reading to reorganize, and 4% was for critical text-sense reading. The hard copy reading of the more experienced writers showed a different pattern. Of the 80 instances of hard copy reading by more experienced writers, only 31% of the instances were for checking formatting; 9% were for proofreading, 21% for reading to reorganize, and 39% for reading for a sense of text. (See Figure 4.)

Figure 5 presents the data in another way, and shows both the high incidence of format checking by student writers and the fact that the hard copy reading of the more experienced writers was more evenly distributed across the four uses.

[Insert Figures 4 and 5 here.]

One possible conclusion from this comparison might be that students do no do the kind of reading required for reorganization or whole-text revision, and that they don't read their texts critically or worry too much about a "sense" of the whole text.

However--while that may in fact be the case--we developed another possible explanation. From the interviews, writing process logs, and observation session notes, we noticed that **how** the more experienced writers used hard copy seemed to be dependent on the **kind of task** they were doing. So we reanalyzed that data; we went back to the logs and interviews and pulled out those instances of reading problems which were clearly tied to specific kinds of tasks, as reported by the writers.

Two kinds of task variables were examined: task length and task "familiarity;" i.e., whether the writing task was well-rehearsed or "knowledge forming." We did not analyze the texts themselves for either quality. Rather, we took the writers' word for it; i.e., if a writer said a task was long or short, familiar or new, then that is how it was coded in this analysis. While this means that a text of 1000 word written by one writer could be coded as short, while one of a similar length by another writer could conceivable be coded as long, we believed that the writers perceptions of tasks length and familiarity were more important for this analysis than any pre-determined categories of length or familiarity.

There were 40 instances which we were able to code along the task length dimension; almost twice as many instances were associated with long tasks. Table 6 shows how hard copy was used for tasks that writers called long and short. While the short tasks seemed to elicit

hard copy use mainly for checking formatting and proofreading, writer used hard copy for all four purposes when they were writing long tasks.

The two categories in the familiarity dimension were "rehearsed" and "knowledge-forming." Of the 27 instances of hard copy use that were associated with "rehearsed" and "knowledge-forming," fully twice as many were tied to the more difficult "knowledge-forming" writing. Table 7 shows the patterns of hard copy use for "rehearsed" and "knowledge-forming" tasks. The rehearsed tasks elicited hard copy use only for formatting and proofreading, while the knowledge-forming tasks employed hard copy for all four purposes. Using hard copy to read for text sense seems especially important for long and/or knowledge-forming tasks.

[Insert Tables 6 and 7 here]

By comparing Table 5 to Tables 6 and 7, we can see that the shape of the graph representing the short tasks and the one representing the rehearsed tasks resemble the graph for student writers. This study, while observational and exploratory, suggests two strong hypotheses about writing with word processors:

> First, some writing tasks may elicit more hard copy use, and the patterns of hard copy use may be different for long and short tasks, and for rehearsed and knowledge-forming tasks.

> Second, these students may have doing short, well-rehearsed writing tasks; the more experienced writers may have been doing very different tasks.

Reading, reviewing, evaluating are important in writing. If evaluative reading is problematic on-line--and if these problems are tied to particular kinds of writing tasks--a logical inference would be that the word processor accomodates or invites some writing tasks more than it does others.

One of the writers expressed this notion very well in an interview:

> [Creating] class assignments and stuff like that are pretty second nature to me--I can write those in my sleep, and so I'm usually pretty confident that if I've spelled the word correctly and it read like English, then it's fine. But when I'm in a more creative mood, like when I'm trying to argue for something or express new ideas or things that I'm working on my self, I'm less secure in that, less secure in just having it on the screen.
>
> You know, it maybe that writing is learning things. It may be that in those other assignments [harder ones], as you write then you're developing--I'm developing the argument or I'm developing the information that I want to give and so, it demands that I look at it again, on paper, and say OK, this is really OK. I wouldn't want to think how many hard copies or how many times I've done the same section--in my dissertation. And then you say, forget the whole thing and start all over. Whereas some of the other things [shorter,easier] I think, you know, the nature of the task is such that you can look at it on-line right away and say that fine, that's it.

What this writer seems to be saying is that some tasks--short, well-rehearsed--are easy to write and evaluate on-line. Other tasks--longer, more complex ones-are difficult to evaluate on-line and require hard

copy to supplement word processing.

What are the implications of this study for using word processors in the writing curriculum? Certainly verification and converging evidence are necessary, but if this is the case--if some kinds of writing are better suited to the word processor, and if using word processing can compound some kinds of student writing problems--what are the educational implications?

We *could* --maybe we should--design assignments for computer writing classes that are short, and well-rehearsed in order to help students avoid on-line evaluation problems. This may not be what we want to do, given our educational objectives.

A more long term solution would be to determine, though further research, what kinds of computer variables lead to reading difficulties and work with software developers and system designers to alleviate the problems.

Right now, however, we can make explicit to our students the dangers of relying completely on the word processor and point out to them the ways in which they might use hard copy to supplement their computer writing, especially to read their own developing texts.

I think we sometimes forget that behavior that to us is second nature may need to be made explicit to our students. Matt's teacher--Diane-- is very savvy and very self-aware about using hard copy to supplement her computer writing. It wouldn't occur to her to "do without" hard copy. For Diane, using word processor does not mean foregoing pen and paper. But it doesn't occur to Matt that he need to use paper at all--in fact he prides himself on doing without it. Given the fairly conclusive research on difficulties reading on-line, it seem that Matt may be making a mistake. Somehow either Diane had not given the message--or Matt had not gotten it--that writing with a word processor may not mean foregoing pen and paper.

When we teach, encourage, or even require our students to use a word processor for writing, we make explicit for them when and how the machine can help them. We also need to make explicit when relying on conventional technology is the smarter move to make. As the use of word processing programs becomes more widespread in classrooms and in offices of writers and academics, we are given both the need and the opportunity to find out more about the effects of computers on the processes of writers who use them.

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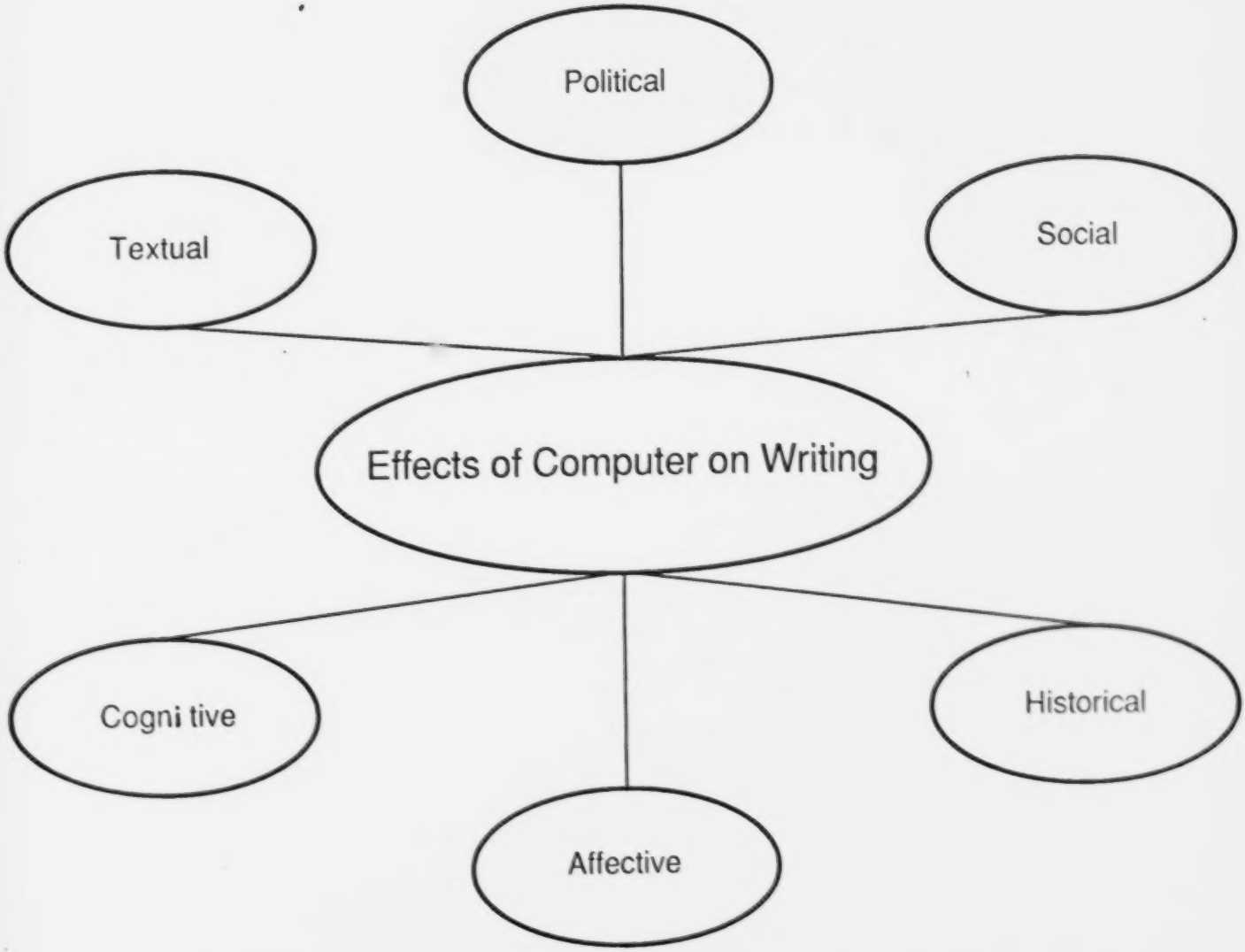
Political
Textual
Social
Effects of Computer on Writing
Cogni tive
Historical
Affective

Figure 1

Use of Hard Copy for Reading Their Own Texts:

Sample Writer One

Diane: teacher, PhD candidate, software developer, and writer

Comments from log about why writer was using hard copy:

need to see what I've said--and in what order

to read and make changes on paper--also mark places that need more work

I need sense of whole text--print with duplex so I can see pages side by side

to read to see if some parts are redundant or out of place

Excerpts from interviews:

CH: What does the hard copy do for you?

Diane: It's sort of corny, but the first thing that came to my mind was, it makes it seem like a paper...all these little blinky lights and stuff...I trust this machine, but... it doesn't really seem like a paper until I have it on the paper, you know?

CH: What do you mean?

Diane: It makes it more real? I don't know. Substantial, concrete? I don't know why but I do still get hard copy and I alway read the hard copy and I've learned to--this is funny--I now read my prose the way I read a book. And now I will go through my papers and mark them just like I mark the book, the main points, and in the margins I write where I have questions. I'll look for the best sequence, I'll mark in the margins where I've been vague...I can't get that distance here [on the screen].

Figure 2a

Use of Hard Copy for Reading Their Own Texts:

Sample Writer Two

Matt: freshman, 3-years experience with computers, A-student in high school English

Comments from log about why writer was using hard copy:

to see how long it is

to turn in

Excerpts from interviews:

CH: Why did you print it?

Matt: To turn in.

CH: Was that the only reason, did you need a hard copy for some reason?

Matt: No, that was the reason--she just wanted a hard copy to look at.

*****

Matt: So I pretty much left it like that [like I typed it in].

CH: Did you make any kinds of revisions?

Matt: Not really.

CH: Or print it out?

Matt: Not really.

CH: Or--

Matt: That was just it.

CH: And then you made a print-out for your teacher?

Matt: Actually, this one I mailed. We sent our papers through the mail.

Figure 2b

Reading One's Writing On-Line:

Four Problem Areas

Formatting

I want to check it for double-spacing

I want to see if the tables line up.

I get a print-out every little while to see if it's long enough yet.

Proofreading

I read for misspellings much better on paper.

The glare bothers me if I'm trying to read closely, say to proofread.

Reorganizing

I need the hard copy to see if things are really out of order.

I read to check the logical sequence of the ideas. You know, sometimes you just have to get your pen and spread the thing [the text] out all over the floor.

I try putting parts together--you know, holding up sections next to each other and reading them--to see if I really want to go through a big revision, a big reorganization.

Critical Reading, or the "text sense" problem

I need to really see what I've said--I need to get a sense of the whole text.

I tend to forget the part of the text I'm not seeing--what came before or what comes after--even though I can scroll to it.

I just get a print out and read it from paper every so often--to see that I'm still on track and that things are developing right.

Figure 3

Use of Hard Copy for Reading

(- Data -)

	Students	More Experienced Writers
Formatting	75 %	31 %
Proofreading	13 %	9 %
Reorganization	8 %	21 %
"Text Sense"	4 %	39 %
	T = 75	T = 80

Figure 4

Use of Hard Copy for Reading

(- By Subjects -)

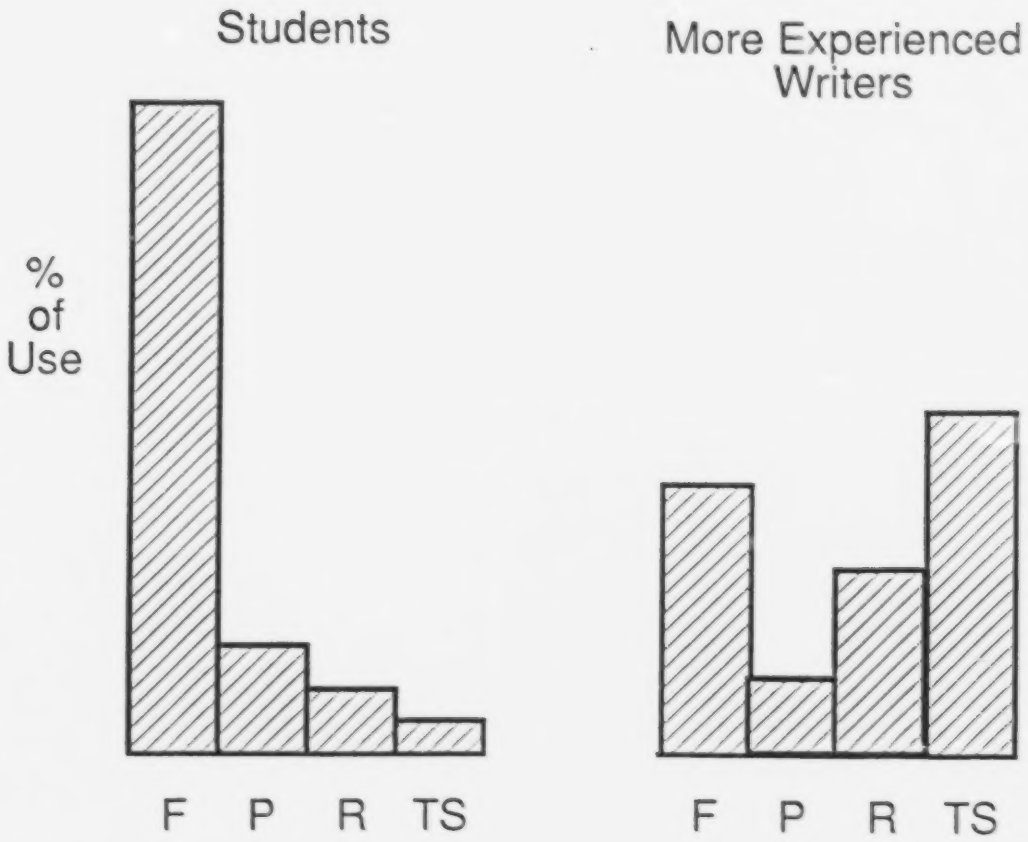

Figure 5

Use of Hard Copy for Reading

(- By Task -)

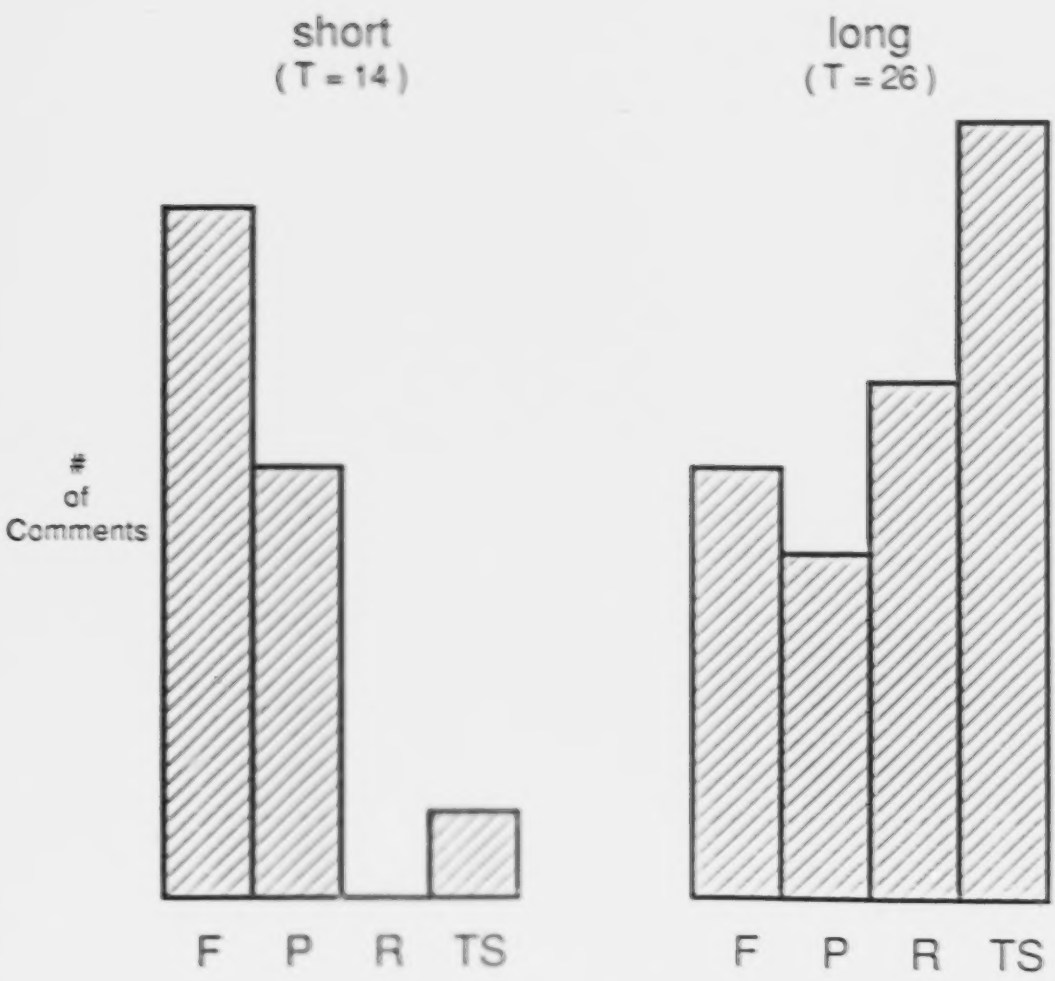

Figure 6

Use of Hard Copy for Reading

(- By Task -)

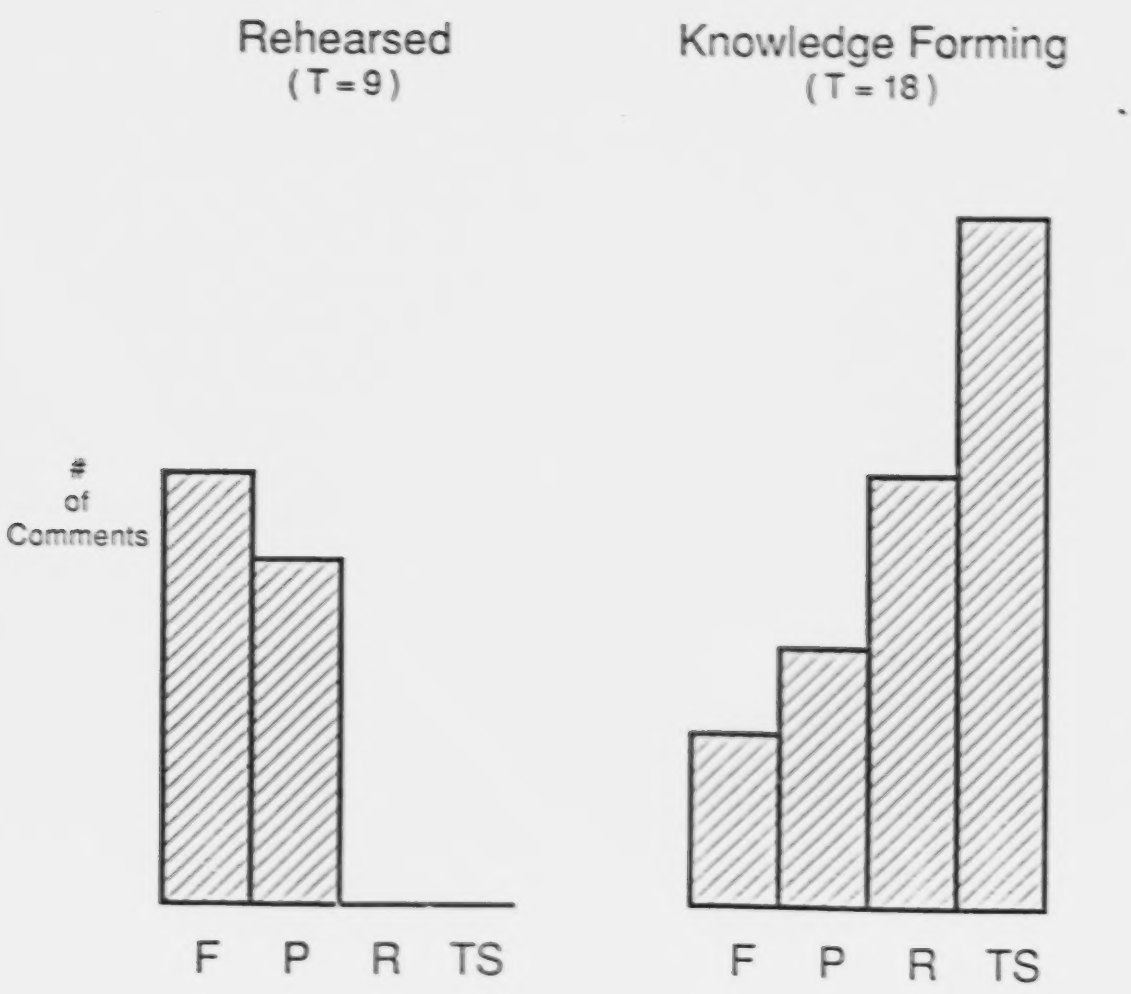

Figure 7